1044-106 Is Continuous ST Monitoring a Better Predictor Outcome Than Enrolling Electrocardiogram in Acute Myocardial Infarction?

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The GUSTO-I trial showed that certain enrollment variables predict 30-day mortality after MI. Peak lead ST elevation (STPK) on enrollment ECG was not predictive, though this is the variable that drives treatment. We theorized that the peak was not obtained on the static enrollment ECG, with loss of predictive information. We evaluated peak ST elevation on enrollment ECG vs peak ST elevation in the primary lead during continuous (CONT) 12-lead ST monitoring in the GUSTO-I and TAMI-9 acute MI substudies, using patients as their own controls (N = 492). Endpoints were combined death or new CHF, or no death or CHF at 30 days. No significant differences in age, sex, prior MI, hypertension, smoking, diabetes, peak CK, time to treatment (TTT) or ejection fraction (EF) were seen. Results were:

Death		Peak TTT			Lytics to Enrollment			CONT
CHF	N	CK	hrs	EF	STPK[a]	STPK[b]	STPK[c]	STPK[d]
Yes	140	2200	2.8	60	(0–63)	40.0	325 μV	525 μV
No	352	1233	2.7	55	(0–29)	35.8	300 μV	438 μV

[a]Range (min), [b]percent PK on enroll ECG, [c]p = 0.159, [d]p = 0.0048

Conclusions: Enrollment ECG failed to identify true peak ST in 60% of AMI pts. There was a trend for later peaks in pts. with poor outcome. Peaks were identified within the first 6 hours in 95% of pts. Thus, true ST peak is predictive of outcome when continuous 12-lead ST monitoring is used.

1044-107 Posterior Chest Leads (V_{7-9}) ST↑ During Acute Inferior Infarct Predicts Larger Infarct and Better Benefit From Thrombolysis

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Since the beneficial effect of thrombolysis is proportional to the amount of jeopardized myocardium, patients (pts) with inferior myocardial infarct (IMI) and posterior involvement may receive greater benefit from thrombolysis than other IMI pts. However, the early identification of these pts is hampered by the absence of ST↑ reflecting posterior MI on standard EGG. To determine the value of ST↑ in posterior chest leads (V_{7-9}), to facilitate the diagnosis of posterior involvement, and to evaluate the effect of thrombolytic therapy in this subgroup of IMI pts, we studied 87 pts with first IMI, treated with rt-PA. Pts were divided into 2 groups: 46 (53%) with ST↑ in V_{7-9} (Group A) and 41 (47%) without (Group B). Group A had more frequent posterolateral wall motion abnormalities on adission radionuclide ventriculography (87% vs 46% $p < 0.001$), higher peak CK (1254 ± 673 vs 847 ± 723, $p < 0.05$) and lower LVEF (53 ± 14 vs 60 ± 9, $p < 0.008$), than Group B. To determine the beneficial effect of thrombolysis, pts were stratified according to the patency of the infarct artery on angiography. While in Group A patency resulted in better LVEF (56 ± 13 vs 44 ± 12, $p < 0.012$), in Group B the EF was preserved regardless of patency. *In conclusion:* 1) ST↑ in V_{7-9} identifies IMI pts with posterior involvement. 2) IMI pts with ST↑ in V_{7-9} benefit more from thrombolysis, as compared to those without.

1044-108 ST-segment Elevation in Leads I and aVL in Acute Anteroseptal Myocardial Infarction is an Independent Risk Factor for Left Ventricular Rupture

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Background: It is difficult to determine which patients have a risk of cardiac rupture after acute myocardial infarction. *Objectives:* The purpose of this study is to determine the usefulness of electrocardiography (ECG) in the emergency room for assessment of the risk of cardiac rupture after acute anteroseptal myocardial infarction (AS-MI). *Methods:* The presence of ST-segment elevations on emergent 12-lead ECGs in 364 consecutive AS-MI patients was evaluated. Patients with complete bundle branch block were excluded. A forward-stepwise logistic regression analysis for cardiac rupture was performed with covariants of age, gender, and ST-segment elevations in leads I, aVL, and V1–V6. *Results:* Cardiac ruptures were observed in 16 patients, 7 with left ventricular free-wall rupture (FWR) and 9 with ventricular septal perforation (VSP). For FWR, ST-elevation in lead aVL was the only independent factor (odds ratio = 5.4, 95% C.I. = 1.6–18.7, P = 0.0078). For VSP, female gender (odds ratio = 7.7, 95% C.I. = 1.8–33.1, P = 0.0064) and ST-elevation in lead I (odds ratio = 6.4, 95% C.I. = 1.5–27.5, P = 0.0134) were independent factors. For left ventricular cardiac rupture, female gender (odds ratio = 4.2, 95% C.I = 1.4–12.9, P = 0.0116) and ST-elevation in lead aVL (odds ratio = 3.5, 95% C.I = 1.8–6.7, P = 0.0002) were both independent factors. *Conclusion:* In pts with acute AS-MI, the ST-segment elevation in leads I and aVL is an independent risk factor for left ventricular rupture.

1044-109 Occurrence of Ventricular Fibrillation During Acute Myocardial Infarction: Prediction by Dynamic Continuous 12 Lead ECG ST-Segment Variables

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The objective of this study was to assess whether continuous 12 lead ECG ST-segment changes during the first 3 hours of recording could predict or affect the occurrence of ventricular fibrillation (VFib) during acute myocardial infarction (MI) treated with thrombolytic agents. 533 patients undergoing continuous 12 lead ECG ST segment monitoring were included in the study. The variables analyzed included: 1) the time to steady state of the ST (Time SS); 2) number of ST transition episodes; 3) the peak of the ST deviation (ST peak); 4) and the ST curve area (ST area). To evaluate the effects of different ST segment transition patterns, patients were divided as follows: 1) those with 1 ST transition; 2) those with 2 ST transitions; 3) those with ≥ 3 ST transitions (cyclic flow). Both patients with and without VFib were equally distributed in the three groups (p = NS). The remaining ST variables in the VFib and no VFib groups are shown. Values are reported as percentages of median (25th, 75th) percentiles.

	ST Peak	ST Area	Time SS
VFib = Yes	738	9197	180
Vfib = No	498	4977	124
p Value	0.0001	0.0003	0.19

In conclusion: (1) ST-segment variables looking at the area of myocardium infarcted and at risk, predict VFib in MI treated with thrombolytic therapy; (2) frequent episodes of ST segment transition are not associated with either a higher or lower occurrence of Vfib.

1045 Cardiac Pacing/Rate Adaptive Pacing

Wednesday, March 19, 1997, 9:00 a.m.–11:00 a.m.
Anaheim Convention Center, Hall E
Presentation Hour: 9:00 a.m.–10:00 a.m.

1045-110 Permanent Biventricular Pacing by a Transvenous Approach

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The benefit of chronic DDD pacing (DDD-P) to treat end-stage congestive heart failure (CHF) remains controversial. But compared with single right ventricular (RV) DDD-P, biventricular synchronous pacing (BVSP) was recently shown as capable to improve symptoms dans hemodynamics in patients with dilated cardiomyopathy (DCM) and drug-refractory CHF. In the preliminary reports, the left ventricle (LV) was paced epicardially. The aim of the present study was to examined the possibility of performing permanent BVSP with a totally transvenous lead configuration.

In 24 pts, mean age 68, a very thin unipolar ventricular lead or a specifically designed coronay sinus (CS) lead was introduced into the CS to catheterize selectively a cardiac vein over the LV free wall. The tip electrode was introduced as distally as possible up to a blocked position. The procedure was successful in 17 pts (72%) with a final placement in the great cardiac veine (n = 3), ini a lateral vein (n = 6), in a posterolateral vein (n = 7) and at the LV apex through the mid-cardiac vein (n = 1). The mean acute pacing threshold was 1.2 ± 0.8 V and the average intracardiac signal amplitude was 15 ± 5 mV. The RV lead was placed at the apex or in the outflow tract. The 2 ventricular leads were connected through a Y adaptator to a dual-chamber (biventricular) pacemaker (PM) in 3 pts, to a "triple-chamber" PM in 10 pts and to a "four-chamber" PM in 4 pts.

After a mean follow-up of 7 months (2–18), 16 of 17 transvenous LV leads were functional whith a mean chronic pacing threshold of 2.1 ± 1 V and an average intracardiac signal amplitude of 17 ± mV. SBVP was effective and permanent in these 16 pts.

With the currently available lead technology, permanent transvenous LV

pacing can be successfully achieved in more than 70% of DCM pts. New lead technology should probably result in significantly better success rate in the near future.

1045-111 Feasibility of Measuring the "Optimal Atrioventricular Delay"

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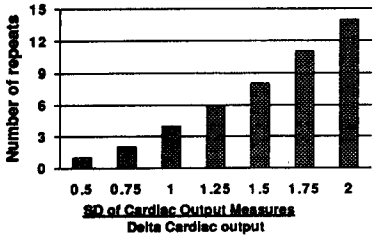
Individual programming of the atrioventricular delay (AVD) has been suggested to be useful, especially in patients with heart failure. However, a single measurement of the best AVD may be unreliable because of variability in cardiac output (CO). To determine the feasibility of measuring the optimal AVD, we calculated the number of times measurements would have to be repeated to achieve a 90% probability of finding the true optimal value. Probabilities were found by computer simulation of 25000 hypothetical pts with normal random variation. 5 AVDs were tested with uniformly spaced true mean CO. The figure shows the number of repeats required which depends on the ratio of standard deviation (SD) of repeat measures of CO *to* the change in CO with a change in AV interval. In 13 pts with pacemakers, tested on 3 occasions a week apart, the SD of Doppler CO was 359 ml and the change in CO with a 25 ms change in AVD was 212 ml (307 ml for a 50 ms change in AVD). Thus, in this example, measurements would need to be repeated on > 10 separate occasions to be reasonably certain of finding the best AVD within 25 ms and 6 times to find the best AVD within 50 ms.



Thus, a precise determination of the optimal AVD is impracticable in most pts because the change in CO as the AVD changes is less than the variability in CO measurement.

1045-112 Minute Ventilation during Submaximal Exercise: Influence on Respiratory Driven Rate Adaptive Pacing

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Detection of minute ventilation (VE) by intrathoracic impedance changes has been established in rate adaptive pacemakers. During initiation of exercise, it is known that other devices e.g. muscle activity driven pacemakers may generate a faster paced heart rate response. The objective of this study was to analyze whether the kinetics of minute ventilation (VE) offer, in combination with the kinetics of respiratory rate (RR) and tidal volume (Vt), the potential of a more prompt and normal response. *Methods:* 61 healthy normals (age 46 ± 16 ys) were exercise tested on a treadmill using the "Low Intensity Treadmill Exercise"- protocol (LITE). Respiratory parameters were collected "breath by breath" with a MedicalGraphics CPX/D system. Kinetics of VE, Vt and RR were determined by linear regression analysis at 20 sec and 30 sec after initiation of exercise and at steady state (STS). *Results:* 20 sec after initiation of exercise Vt increased up to 978 ± 325 ml (30% of the resting value) and after 30 sec to 1085 ± 405 ml (45%). The increase of RR after 20 sec was lower: 19.5 ± 6.7 breaths/min (19%) and after 30 sec 19.5 ± 6.3 breaths/min (18.9%). The increment to STS was 71% (1278 ± 521 ml, Vt) and 22% (19.8 ± 5.8 breaths/min, RR) corresponding to a dynamic increase of 285 ml/min (Vt) und 1.5 breaths/min (RR) from rest to STS. *Conclusions:* Tidal volume shows a more marked increase at the initiation of exercise than respiratory rate. Simultaneous detection of tidal volume kinetics and minute ventilation with a modified algorithm may offer better discrimination of the early exercise phase. Improved reactivity of a minute ventilation sensor may generate a faster paced heart rate response during daily submaximal exercise.

1045-113 Proposal for a Novel Minute Ventilation Based Rate Adaptive Pacing Algorithm

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Current 3rd generation minute ventilation (VE) based rate adaptive pacing algorithms require a complex biphasic linear slope programming in order to appropriately match metabolic demand and paced heart rate (HR). It was the purpose of this study to determine a mathematical expression of the HR to VE relationship allowing one to design a pacing algorithm which is more simple to program for the physician and still guarantees a high correlation to the normal sinus node's response to various intensity levels of activity. Eighty-four healthy adults (34 women and 50 men, mean age: 44 ± 16 yrs) were exercised on a treadmill with "breath-by-breath" gas exchange monitoring using the symptom limited "ramping incremental treadmill exercise" (RITE) protocol. The HR to VE relationship was analysed performing (1) a linear regression analysis from rest to anaerobic threshold (AT, slope A) and from AT to peak exercise (slope B), (2) a natural logarithmic (lnx) expression from rest to peak exercise and (3) a linear expression of the logarithmic transform (logtrnf) function for the HR or y-axis variable.

	Study group	Women	Men
HR/VE (A)	1.51 ± 0.44 (r: 0.92)	1.72 ± 0.38 (r: 0.92)	1.35 ± 0.42 (r: 0.93)
HR/VE (B)	1.04 ± 0.4 (r: 0.94)	1.2 ± 0.46 (r: 0.91)	0.94 ± 0.25 (r: 0.95)
lnxHR/VE	49.1 ± 9.5 (r: 0.96)	48.9 ± 10.0 (r: 0.96)	49.1 ± 9.1 (r: 0.97)
logtrnfHR/VE	0.4 ± 0.08 (r: 0.97)	0.4 ± 0.07 (r: 0.97)	0.41 ± 0.08 (r: 0.98)

The analysis of the HR to VE relationship throughout peak exercise using the lnx expression or the logarithmic transformation of the y-axis variable demonstrated the highest correlation coefficents among the calculations performed. A rate adaptive pacing algorithm using a logarithmic expression of HR to VE ratio instead of a linear coupling could generate a paced rate response to exercise which closely simulates the normal sinus node, independent of gender. Since the lnx and the linear slope of logtrnf HR to VE appropriately represent the HR to VE relationship during various work load levels, a future 4th generation pacing algorithm would no longer require a different rate response programming for different levels of activity.

1045-114 Oxygen Uptake Kinetics During Low-Intensity Exercise Testing: Relevance for Rate Adaptive Pacemaker Programming

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The pacemaker's response time and its rate response factor are known determinants of oxygen uptake (V02) and oxygen deficit during low-intensity exercise testing. The purpose of this study was to establish a normals data base for oxygen uptake kinetics as a guideline for the programming of rate adaptive pacemakers and to determine its relationship to V02 at anaerobic threshold (AT) and peak exercise. Sixty healthy subjects (23 women: 51.6 ± 20.4 yrs, 37 men: 42.2 ± 16.2 yrs) performed treadmill exercise with "breath-by-breath" gas exchange monitoring using (1) the "Low-Intensity Treadmill Exercise" (LITE) protocol for a submaximal work load level of 35 external watts and (2) the "Ramping Incremental Treadmill Exercise" (RITE) protocol for peak exercise testing. (1) LITE protocol: V02 at steady state (STS) was 1040.6 ± 146.9 ml indicating an increase of 838.3 ± 369.9 ml above resting levels. The "mean response time" (MRT) of V02 or the inverse of the rate constant for the rise in V02 prior to reaching STS levels was 35.1 ± 9.9 s with a mean 02 deficit of 418.3 ± 147.9 ml. The 02deficit/V02 uptake ratio during the dynamic phase times the time from rest to STS was 55 ± 17 s. (2) RITE protocol: V02-AT was 22.1 ± 5.7 ml/kg/min, heart rate (HR) at AT: 120.1 ± 13.6 bpm; V02-peak was 37.6 ± 10.7 ml/kg/min with a peak HR of 167.8 ± 19.3 bpm. The MRT and 02deficit/V02 time index were significantly correlated to V02-peak and V02-AT ($p < 0.01$ for both MRT and 02 deficit/V02 time index). Oxygen uptake kinetics may serve as a control data base for the assessment of different pacemakers' "rate response factors" or response times and their influence on oxygen uptake during low-intensity exercise. Since functional, aerobic capacity below the anaerobic threshold more likely represents daily life activities and the kinetics of V02 are significantly related to V02 at both anaerobic threshold and peak exercise, low-intensity exercise may provide a clinically useful correlate or even substitute to peak exercise testing.